Agroclimate Monitoring in the San Joaquin Valley

1958-1991

California Department of Water Resources

San Joaquin District

STATE OF CALIFORNIA

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Evaporation *data from pans located throughout California are vital components of hydrologic analyses. The Department of Water Resources has collected and published such data for more than 60 years. Initially, the Department used these data to estimate losses from lakes and reservoirs.*

Then, in the late 1940s, irrigation engineers and agricultural scientists demonstrated a close relationship between crop water use (evapotranspiration) and evaporation from pans and atmometers. In the early 1950s, research results led to the first standards in the physical design of evaporation pans. By the mid-to-late 1950s, the effects of pan surroundings and water depths on evaporation rates were well documented. In the late 1950s, the Department undertook a statewide study to operate pans and atmometers in accordance with the research results mentioned above.

This report documents the portion of that study conducted on the floor of the San Joaquin Valley. The plan was to (1) operate a master climate station at one southern Valley location (near Bakersfield) on a continuous basis for many years and (2) operate smaller, auxiliary stations for shorter periods of time to sample climates at other sites throughout the Valley.

All stations were located in well managed irrigated pasture environments. A United States Weather Bureau Class 'A' pan was installed at each station and equipped with a water supply tank and float valve system to maintain a near constant water level. Ancillary instruments used in the study were of a traditional, proven, robust design. They required servicing once a week. A standard instrument layout was applied for the outlying agroclimate stations. The calibration, installation, and operation of these instruments are described later in this report. Within the station environment, pasture grasses were maintained at a 3-to-5-inch height by mowing as required.

During the period 1958-1991, agroclimate data on solar radiation, pan evaporation, atmometer evaporation, air temperature, precipitation, wind movement, and soil temperature were collected at about 20 locations in the Valley. These data, summarized into weekly and monthly amounts, are presented in this report. They show little variation from place to place for the same year, and little variation within the same geographic area for different years.

Conception, *implementation, and execution of this investigation during the early formative years were carried out under the direction of the following Department of Water Resources supervisors:*

John W. Shannon
Supervisor of Statewide Land and Water Use Programs

J. H. "Jack" Lawrence
Supervisor of Statewide Urban and Vegetative Water Use Programs

R. E. "Gene" Merrill
Supervisor of Statewide Vegetative Water Use Program

These three men, now deceased, are remembered not only as exacting supervisors, but as loyal friends and valued colleagues.

Climate data presented in this report are a tribute to those dedicated individuals who carefully collected the field data. Measurements were made and stations were maintained on schedule without regard to inclement weather and other adverse conditions. Thanks are due:

For stations near Bakersfield:

Zene D. Bohrer, Jr.
Robert V. Butt
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Special recognition is due L. R. "Larry" Glandon, who not only did an outstanding job installing and maintaining the outlying stations and collecting and analyzing data from those stations but also contributed much to the development of the techniques and procedures used at all stations.

James D. Goodridge, former State Climatologist, generously provided advice, counsel, and encouragement during the course of this investigation.

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Introduction

Data *presented in this report were collected as part of a statewide investigation of agricultural climate (agroclimate). Such data provide a basis for estimating crop water requirements. This report includes data collected at some 20 locations on the floor of the San Joaquin Valley. Agroclimate station locations are shown on Figure 1. More exact locations and station descriptions are listed in Table 1. Field procedures followed and methods of data analysis are described.*

BACKGROUND

By the 1940s and early 1950s, a close correlation between consumptive use of crops and evaporation from pans and atmometers had been demonstrated by irrigation engineers and agricultural scientists. Crop consumptive use was shown to be related to evaporation from a pan of specific design. However, Arthur A. Young and others demonstrated marked differences in evaporation from pans of different designs at the same location (Young, 1947). In the 1950s, Blaney and Muckel published measured differences in evaporation rates from pans of six different designs (DWR Bulletin 73, 1959). Goodridge identified 24 different designs for pans operated in California (DWR Bulletin 73-1, 1974).

Other studies indicated that the procedures followed in operating pans of identical design also influenced the rate of evaporation. For example, U.S. Weather Bureau researchers found that variations in pan water depth markedly affected the rate of evaporation from Class 'A' pans (Nordenson and Baker, 1962).

Arvin-Frick Master Agroclimate Station. One of three evaporation pans. Robert Wendt, left, Daryl Nichols, on the right.

FIGURE 1

Location of Agroclimate Stations—San Joaquin Valley—1958-1991

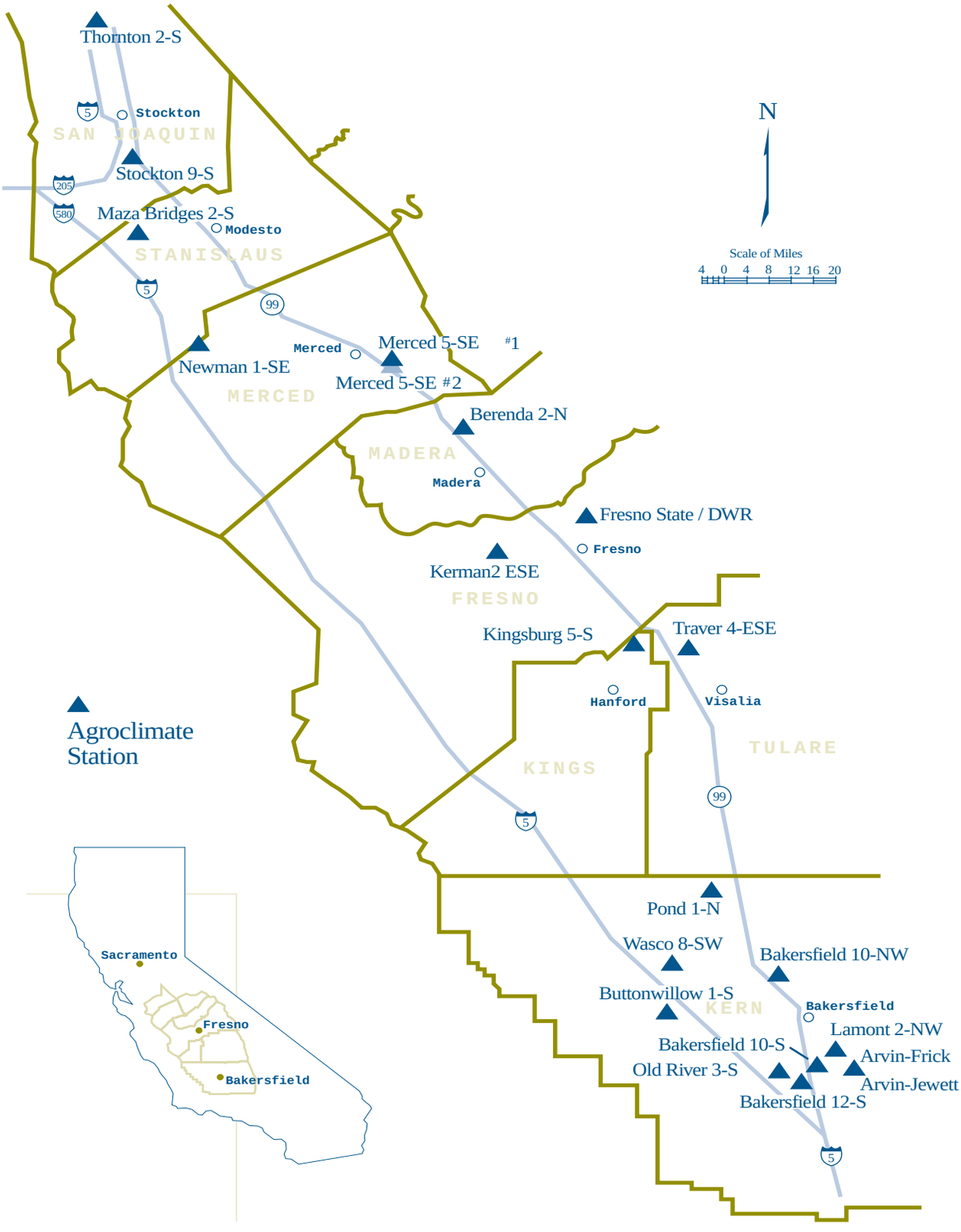

TABLE 1

Agroclimate Stations on San Joaquin Valley Floor 1958-1991

STATION	COOPERATOR	LOCATION				INSTRUMENTS							RECORD	
		TOWNSHIP, RANGE, SECTION, AND TRACT*	LONGITUDE	LATITUDE	ELEVATION AT MEAN SEA LEVEL (FEET)	EVAPORATION	ATOMETER	WIND MOVEMENT	AIR TEMPERATURE MAX./MIN.	AIR TEMPERATURE RECORDING	PRECIPITATION	RADIATION	BEGINS	ENDS
Arvin-Frick	Howard Frick	T31S/R29E16F	35°13'58"	118°52'08"	437	•	•	•	•	•	•	•	6-01-59	10-15-65
Arvin-Jewett	Jewett & Pomeroy Farms	T31S/R29E16G	35°13'56"	118°52'07"	440	•	•		•		•		4-01-58	5-31-59
Bakersfield 10-NW	Kern County Industrial Farm	T28S/R27E18D	35°29'58"	119°06'44"	508	•	•	•	•	•	•	•	11-1480	11-09-90
Bakersfield 10-S	L.D.S. Church	T31S/R28E-8Q	35°14'20"	118°59'20"	329	•	•	•	•	•	•	•	4-08-69	7-01-70
Bakersfield 12-S	Frank Garone	T31S/R27E36D	35°11'34"	119°02'13"	305	•	•	•	•	•	•	•	12-2085	Continues
Berenda 2-N	A. Sallaberry	T10S/R17E17B	37°04'11"	120°08'24"	273	•	•		•		•	•	4-29-59	1-08-64
Buttonwillow 1-S	J. & H. Lewis	T29S/R23E24M	35°23'27"	119°27'42"	270	•	•	•	•		•	•	5-27-65	6-09-66
Fresno State/DWR	W. Strong	T13S/R20E12B	36°49'15"	119°44'29"	340	•	•	•	•		•		1-01-69	Continues
Kerman 2-ESE	J. Cardwell	T14S/R18E17H	36°42'58"	120°01'26"	225	•	•		•		•	•	5-04-60	1-05-65
Kingsburg 5-S	Joe Diaz	T17S/R22E16H	36°27'14"	119°35'00"	277	•	•				•		10-2558	10-10-61
Lamont 2-NW	Mike Yurosek & Son Inc.	T30S/R28E25M	35°17'02"	118°55'40"	380	•	•	•	•	•	•	•	1-22-90	Continues
Maze Bridge 2-S	El Solyo Ranch	T4S/R7E-5J	37°36'57"	121°12'40"	40	•	•	•	•		•	•	2-03-59	6-23-65
Merced 5-SE #1	C. Moyle	T8S/R15E-6M	37°15'58"	120°22'32"	198	•	•				•		1-21-59	1-06-65
Merced 5-SE #2	Ewing Farms	T8S/R15E-7D	37°15'24"	120°22'34"	195	•	•	•	•		•		7-12-64	8-05-68
Newman 1-SE	E. Borba	T7S/R9E-29B	37°18'10"	121°00'07"	78	•	•	•	•		•		5-18-60	6-23-65
Old River 3-S	T. Jarrard	T31S/R27E20D	35°13'16"	119°06'20"	315	•	•	•	•	•	•	•	11-0165	1-01-68
Pond 1-N	D. Mettler	T25S/R25E19E	35°44'26"	119°19'33"	268	•	•	•	•		•		5-31-62	1-03-66
Stockton 9-S	V. & M. Mohr	T1S/R7E-19H	37°50'06"	121°14'18"	27	•	•	•	•		•	•	3-17-59	2-20-62
Traver 4-ESE	W. Rice	T17S/R24E19B	36°26'32"	119°24'33"	285	•	•	•	•		•		3-01-62	1-03-66
Wasco 8-SW	G. Chernobof	T27S/R23E36Q	35°31'50"	119°26'42"	295	•	•	•	•	•	•	•	1-06-75	6-30-81

* Mount Diablo Base and Meridian

The effects of pan physical environment on evaporation rates were also investigated in the 1950s. British agricultural scientists working in North Africa found evaporation from small pans was inversely related to the extent of transpiring vegetation surrounding those pans (Hudson, 1962; Davenport and Hudson, 1967). The influence of surrounding vegetation on evaporation from Class 'A' pans was further defined in University of California studies (Pruitt, 1959).

After carefully evaluating published and unpublished reports, criteria for installing and operating evaporimeters and ancillary instruments for this statewide investigation were developed. Those criteria include the following:

- Evaporation pan to be a standard USWB Class 'A' design.
- Water level in pan to be maintained at near-constant depth.
- Pan to be unpainted galvanized metal.
- Evaporation station to be located within a large area of unstressed low-growing vegetation. (Extensive lawn areas or well managed irrigated pastures meet this requirement.) The upwind fetch of vegetation should be a minimum of 500 feet.
- Agroclimate station to be serviced at least once a week.
- Pan water supply to be fresh tap water.
- Pan to be cleaned as required.
- Livingston black and white spherical atmometers to be operated in sets of three pairs mounted at a height of 54 inches.
- Station fencing (where required) to be of "hog wire" with spacing of about 6 x 8 inches. (Chain-link fencing is to be avoided.)

Servicing atmometers at Arvin-Frick Agroclimate Station. Shown is one of four atmometer pairs at this site. Robert Wendt, left, and Norm MacGillivray, right.

The *objectives of this study were to:*

1. *Determine average (normal) amounts of evaporation demand for the San Joaquin Valley or for specific regions within it.*
2. *Determine year-to-year variations of monthly evaporation at the same location (master station) over a long time period.*
3. *Determine variations between different geographic locations for the same year.*
4. *Collect certain ancillary data to facilitate interpretation of variations in evaporative demand. (These data include solar radiation, wind, and air temperature.)*

MASTER STATIONS

The approach followed was to operate a "master" agroclimate station at one location on a continuous basis, while operating smaller "outlying" stations on a short-term basis to sample agroclimate elements at various other geographic locations on the Valley floor (Figure 1). During the years of this study, 1958 to 1991, the master station was moved several times. These moves were required because in each case the field in which the station was located was rotated from irrigated pasture to field or tree/vine crops and/or the field irrigation system was changed.

For example, in 1965, the area surrounding the 2.5-acre (250 x 440-foot) Arvin-Frick station grassed plot was converted from border strip irrigation to hand-move sprinklers. This caused two problems: (1) the underground concrete pipeline which supplied irrigation water to the field in which the station was located was taken out of service–eliminating that water source for irrigating the border strips in the station plot; and (2) the climate at the station site could have been modified because of spray from the surrounding sprinkler-irrigated fields. The Arvin-Frick master

station was operated for about 6 1/2 years. Instrument layout at the Arvin-Frick site is shown on Figure 2. Immediately after DWR closed the Arvin-Frick station, the instruments were moved about 12 miles west to a surface-irrigated improved pasture. The new master station was designated as Old River 3-S. The fenced station enclosure was 30 x 75 feet. (See Figure 3 for instrument location within the station enclosure.) The Old River 3-S station was operated for about two years (November 1965 to December 1967), when the pasture in which it was located was rotated to an orchard crop. Only one evaporation pan was operated at the Old River 3-S location.

The master agroclimate stations were routinely serviced each week and on the first day of each month. They were also serviced each day that soil measurements were made in nearby crop evapotranspiration field plots.

After December 1967, when the Old River 3-S station was removed, a series of stations of the standard outlying station design were operated near Bakersfield.

OUTLYING STATIONS

Smaller agroclimate stations were operated at various locations and for various periods of time on the Valley floor. These stations were of a standardized design (see Figure 4). They measured 25x25 feet (0.014 acre) and were designed to provide minimum interruption of prevailing winds and minimum shadowing of the various instruments. Actual placement of instruments within the fenced station enclosure was based on sun angles extracted from a syllabus authored by F. A. Brooks, University of California, Davis. Station locations are shown on Figure 1.

View of Traver 4-ESE — A typical outlying agroclimate station.

FIGURE 2

Arvin-Frick Agroclimate Station Instrument Layout

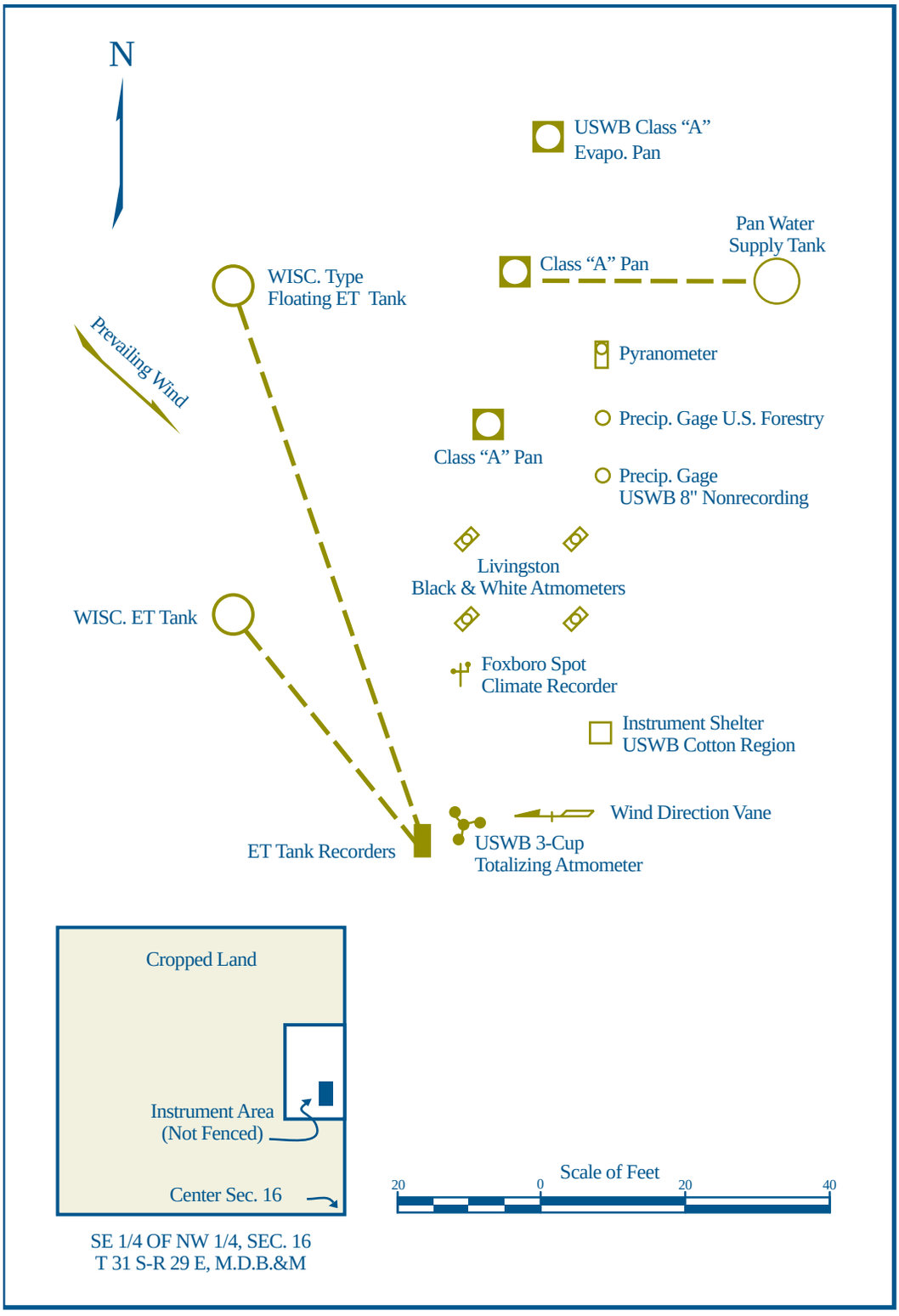

FIGURE 3

Old River 3-S Agroclimate Station Instrument Layout

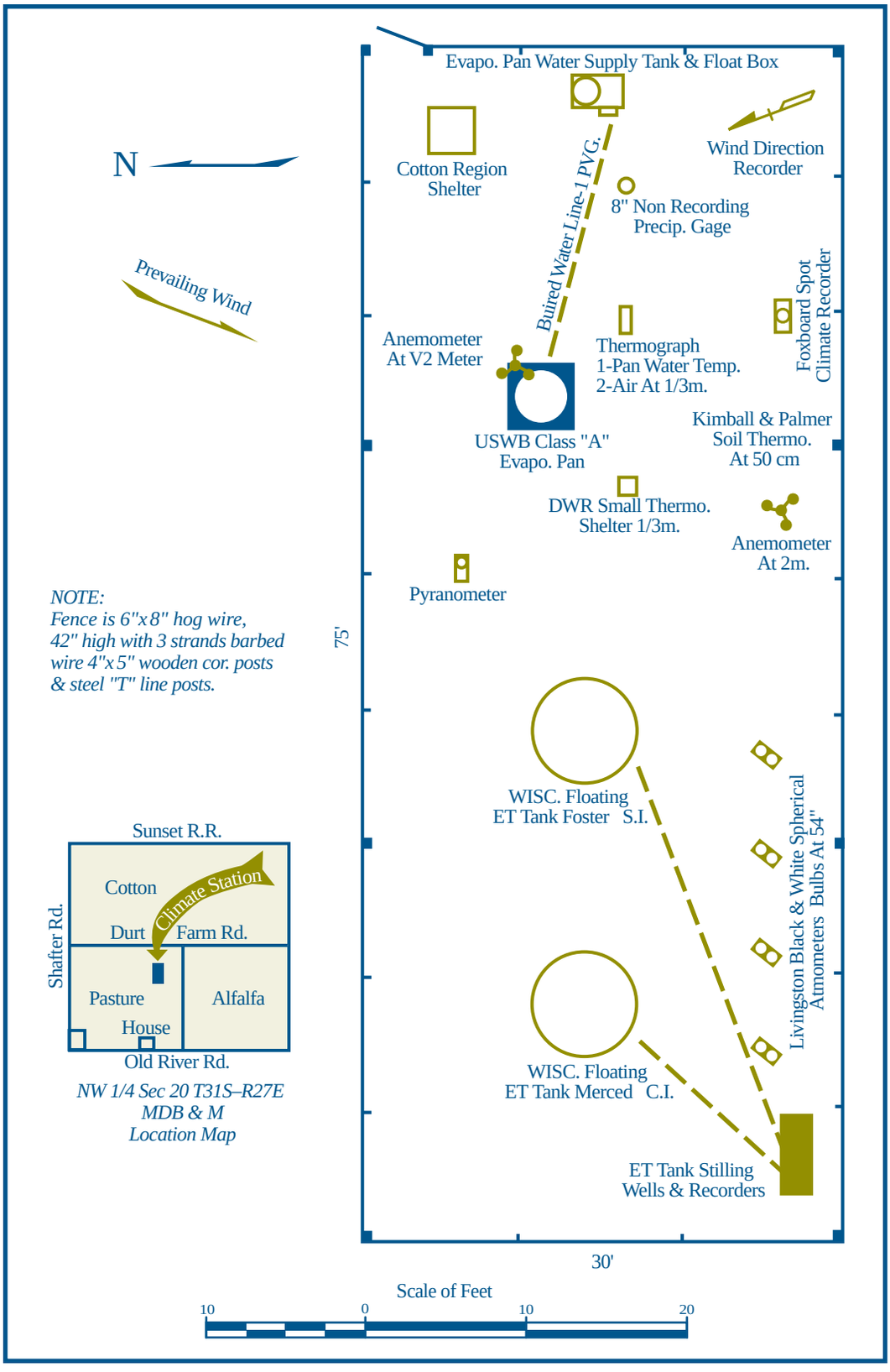

FIGURE 4

Layout of a Typical Agroclimate Station